ANSWERS: Enthalpy change calculations

1. $3H_2O(\lambda) + B_2O_3(s) \rightarrow B_2H_6(g) + 3O_2(g)$ $= +2148$ kJ mol^{-1}

$2B(s) + 1½O_2(g) \rightarrow B_2O_3(g)$ $= -1255$ kJ mol^{-1}

$3H_2(g) + 1½O_2(g) \rightarrow 3H_2O(\lambda)$ $= -858$ kJ mol^{-1}

$2B(s) + 3H_2(g) \rightarrow B_2H_6(g)$ $= +35$ kJ mol^{-1}

2. $3H_2O + 2CO_2 \rightarrow C_2H_5OH + 3O_2$ $+1367$

$2C + 2O_2 \rightarrow 2CO_2$ -394×2 (788)

$3H_2 + 1½O_2 \rightarrow 3H_2O$ -286×3 (858)

$½\ O_2 + 2C + 3H_2 \rightarrow C_2H_5OH$ -279 kJ mol^{-1}

The enthalpy change would be more positive.

Heat energy is absorbed when converting a liquid to a gas. Therefore if the ethanol formed were in the gaseous state, less energy would be released in its formation / products would have a higher enthalpy.

3. Find $H_2(g) + ½\ O_2(g) \rightarrow H_2O(\lambda)$

Given $H_2O(\lambda) \rightarrow H_2O(g)$ $\Delta H = 44$ kJ mol^{-1} (reverse)

$H_2(g) + ½\ O_2(g) \rightarrow H_2O(g)$ $\Delta H = -242$ kJ mol^{-1}

$\Delta_f H°(H_2O(\lambda)) = -44 + (-242) = -286$ kJ mol^{-1}

4. M (NH_3) = 17 g/mol

$n = \frac{m}{M} = \frac{50}{17} = 2.94$ mol

when 4 mol of NH_3 reacts, 1267kJ released

so when 2.94 mol reacts, $\frac{1267 \times 2.94}{4} = 931.6$ = 932kJ released (3 sig figs)

5. *Mr*(HBr) = 80.9

$$n(\text{HBr}) = \frac{m}{M} = \frac{50.0 \text{ g}}{80.9 \text{ g mol}^{-1}} = 0.618 \text{ mol}$$

heat(50.0 g HBr) = $n\Delta_f H°$ (HBr)

= 0.618 mol × 36.2 kJ mol^{-1}

= 22.4 kJ

6. $\Delta_{vap} H°$ (H_2O) = $\Delta_f H°$ (H_2O, *g*) – $\Delta_f H°$ (H_2O, λ) = –241 – (–286) = 45 kJ mol^{-1}

M(H_2O) = 18 g mol^{-1}

Heat required to vaporise 100 g water = 45/18 × 100

= 250 kJ